TRANSFER OF ORGANICS BETWEEN WORLDS.

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During large impact events, copious amounts of debris can be ejected from planet and satellite surfaces. This material is then subject to gravitational and non-gravitational forces that determine its subsequent orbital evolution. These forces eventually bring the ejecta back to the originating world or, more rarely, to another one. Examples of the latter include the rare bits of the Moon and Mars found in terrestrial meteorite collections. These transfers seed the new world with a small compositional sample of the old. Could they also bring organics and biotic compounds from one planetary body to another? We are currently studying the transfer of material between terrestrial planets. Since the fate of large meteorites from Earth has been considered by Gladman etal. (1996, Science), we are focusing on micron-sized dust grains as an alternative. Dust grains have several advantages over large objects: faster-flight times due to non-gravitational accelerations, less heating due to more gentle aerobraking, and sheer numbers. On the negative side are their low carrying capacity and limited shielding against high energy particles. We find that radiation pressure and gravitational scattering from the planets enables direct transfers from Earth to Mars for dust grains smaller than about 4-microns in size. We have also undertaken a numerical study of the fate of material ejected from the four Galilean satellites - Io, Europa, Ganymede, and Callisto. For macroscopic meteoroids affected by gravitational forces only, we find that transfers to different satellite are common, occurring for approximately 15% of escaping material (Fig. 1). We have also run a number of different simulations to investigate the effects of i) different launch velocities and ii) non-gravitational forces on dust grains. A 10% increase in the launch speed more than doubles the number of transfers. Dust grains are subject to radiation pressure and electromagnetic forces which cause half of 1-micron grains launched from Ganymede and over 90% of those from Callisto to be lost to Jupiter. Fig. 1: The results of a 5000-year integration of nearly 8000 particles ejected from the surfaces of the four Galilean satellites (indicated by the capital letters) at the local escape velocity. Particles are launched radially outward from the intersections of a latitude-longitude grid, initially forming an expanding cloud around the source satellite. Subsequent orbital evolution is determined by the gravitational forces from Jupiter, the four satellites, and the Sun. Arrows indicate transfers from one satellite to another, and the associated number shows the percentage of material that makes the given transfer. The downwardly-directed arrow indicates particles lost from the jovian system.